

## CLAIMS

What is claimed is:

1. A seamlessly integrated hybrid optical network device (20), comprising: a semiconductor light source (10) mounted in a cavity in a silicon substrate (11), wherein the semiconductor light source (10) is fabricated from a non-silicon material; and a photonic bandgap (PBG) structure (22) seamlessly integrated with the semiconductor light source (10) to act as an optical wave guide for the photons emitted by the semiconductor light source (10), wherein the PBG structure (22) is etched directly in the silicon substrate (11).
2. The seamlessly integrated hybrid optical network device (20) of claim 1, wherein the semiconductor light source (10) includes a surface covered in a reflective material (25) that blocks emission of photons through the surface.
3. The seamlessly integrated hybrid optical network device (20) of claim 2, wherein the surface includes an optical window (24) that allows photons to pass from the semiconductor light source (10) to the surrounding silicon substrate.
4. The seamlessly integrated hybrid optical network device (20) of claim 3, wherein the PBG structure (22) includes a plurality of porous columns realized in the silicon substrate adjacent to the optical window defined on the surface of the semiconductor light source (10).
5. The seamlessly integrated hybrid optical network device (20) of claim 4, wherein the plurality of porous columns are arranged to define a channel that provides the wave guide for the photons emitted through the optical window.
6. The seamlessly integrated hybrid optical network device (20) of claim 1, wherein the emission of light from the semiconductor light source is regulated by a control system.
7. The seamlessly integrated hybrid optical network device (20) of claim 1, wherein the semiconductor light source (10) is fabricated from a material selected from the group consisting of: SiGe, SiGeC, InP, and GaAs.
8. The seamlessly integrated hybrid optical network device (20) of claim 1, wherein the silicon substrate is fabricated from a material selected from the group consisting of: CMOS, high-speed SiGe, SiGeC, and BiCMOS.
9. The seamlessly integrated hybrid optical network device (20) of claim 1, wherein the semiconductor light source (10) comprises a bipolar transistor that can be biased into an avalanche condition to emit photons.

10. A method of fabricating a seamlessly integrated hybrid optical network device (20), comprising: providing a silicon substrate (11); etching a cavity (41) in the silicon substrate; etching a photonic bandgap (PBG) structure (22) in the silicon substrate (11) proximate the cavity (41); and placing a non-silicon semiconductor light source (10) in the cavity (41).

11. The method of claim 10, wherein the silicon substrate is fabricated from a material selected from the group consisting of: CMOS, high-speed SiGe, SiGeC, and BiCMOS.

12. The method of claim 10, wherein the semiconductor light source (10) is fabricated from a material selected from the group consisting of: SiGe, SiGeC, InP, and GaAs.

13. The method of claim 10, wherein the PBG structure (22) includes a plurality of porous columns arranged to define a channel that provides the wave guide for the photons emitted from the semiconductor light source.

14. The method of claim 10, wherein the semiconductor light source (10) comprises a bipolar transistor that can be biased into an avalanche condition to emit photons.

15. A seamlessly integrated optical network (13), comprising: a non-silicon semiconductor light source (10) mounted in a silicon substrate (11); a photonic bandgap (PBG) structure (22) fabricated in the silicon substrate (11) and seamlessly integrated with the semiconductor light source (10) in the silicon substrate (11) that acts as an optical wave guide for photon pulses generated by the semiconductor light source (10); and a receiving device (27a-d) realized proximate a distal end of the optical wave guide for receiving the photon pulses generated by the semiconductor light source (10).

16. The seamlessly integrated optical network of claim 15, further comprising a control system (29) for regulating the emission of photon pulses from the semiconductor light source (10).

17. The seamlessly integrated optical network of claim 15, wherein the receiving device comprises a photo diode.

18. The seamlessly integrated optical network of claim 15, wherein the semiconductor light source (10) includes a surface covered in a reflective material (25) that blocks emission of photons pulses through the surface.

19. The seamlessly integrated optical network of claim 18, wherein the surface includes an optical window (24) that allows photon pulses to pass from the semiconductor light source (10) to the surrounding silicon substrate (11).

20. The seamlessly integrated optical network of claim 19, wherein the PBG structure (22) includes a plurality of porous columns realized in the silicon substrate adjacent to the optical window defined on the surface of the semiconductor light source (10).

21. The seamlessly integrated optical network of claim 15, wherein the semiconductor light source (10) is fabricated from a material selected from the group consisting of: SiGe, SiGeC, InP, and GaAs.

22. The seamlessly integrated optical network of claim 15, wherein the silicon substrate is fabricated from a material selected from the group consisting of: CMOS, high-speed SiGe, SiGeC, and BiCMOS.

23. The seamlessly integrated optical network of claim 15, wherein the semiconductor light source (10) comprises a bipolar transistor that can be biased into an avalanche condition to emit photon pulses.